GAF: From Design to Explanation of the Learning Process Using an Economics Gaming Intervention

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The Game Analysis Framework (GAF), which was created to provide a visual representation of 'how' and 'why' undergraduate students learn from the playing of educational economics games at tertiary level

GAF brings a unique perspective on the potential of games to provide a rich and complex learning environment because it focuses on the learning occurring within the game space. By introducing deliberative activity via an economics gaming intervention, the students become behaviourally, emotionally and cognitively engaged which enables them to move theory from being abstract to meaningful tools for deciphering economic reality.

BACKGROUND

International literature, over the years, has shown a growing interest in using games as an instructional medium to improve learning in the classroom. Although much has been documented about the potential of games to facilitate engagement, motivation and student-centred learning, there is "little consensus on the game features that support learning effectiveness, the process by which games engage learners and the types of learning outcomes that can be achieved through game play" (Guillén-Nieto & Aleson-Carbonell, 2012, p. 435).

Most of the research that has been undertaken to-date has been quantitative and concentrates on the measurement of performance following the introduction of games into the classroom, comparing these results to traditional 'chalk and talk' methods using treatment and control groups - for instance, it has been shown that the use of games to teach economics improves student achievement (Emerson and Taylor, 2004; Ball et al., 2006); better retention of course material (Nkonyane and van Wyk, 2015); higher student motivation (Gremmen and van den Brekel, 2013) ; as well as a favourable impression of economics (Tsigaris, 2008). However, there is a paucity in the research with respect to specific processes that take place during the playing of the games that encourage learning to occur. It is only once we understand 'how' and 'why' students learn through the playing of educational games, that we will be in a better position to gauge the benefits of using games in the classroom and link the students' experiences, during game play, to the development of deeper conceptual understanding and, as a result, teach economics more effectively.

The aim of this study is a qualitative exploration of the cognitive and learning processes to discover 'how' and 'why' learning occurs through the playing of educational games in the classroom which have been embedded with economics concepts and processes. This will be achieved by mapping the students' experiences of learning, during the introduction of an economics gaming intervention, with the learning outcomes of the games.

GAME FRAMEWORK ANALYSIS

The outcome of the qualitative research which use a case study research design is a theoretical model of 'how' and 'why' students learn from an economics gaming intervention, namely the Game Framework Analysis (GAF). GAF emerged from the combination of research and gaming design perspectives, the resultant framework is a combination of three models due to their clarity of perspective and concise explanations of the gaming process and design, namely:

1. Input-Process-Outcome gaming model developed by Garris, Ahlers and Driskell (2002);
2. The educational gaming model developed by Amory and Seagram (2003); and,
3. Experiential Gaming Model developed by Kiili (2005).

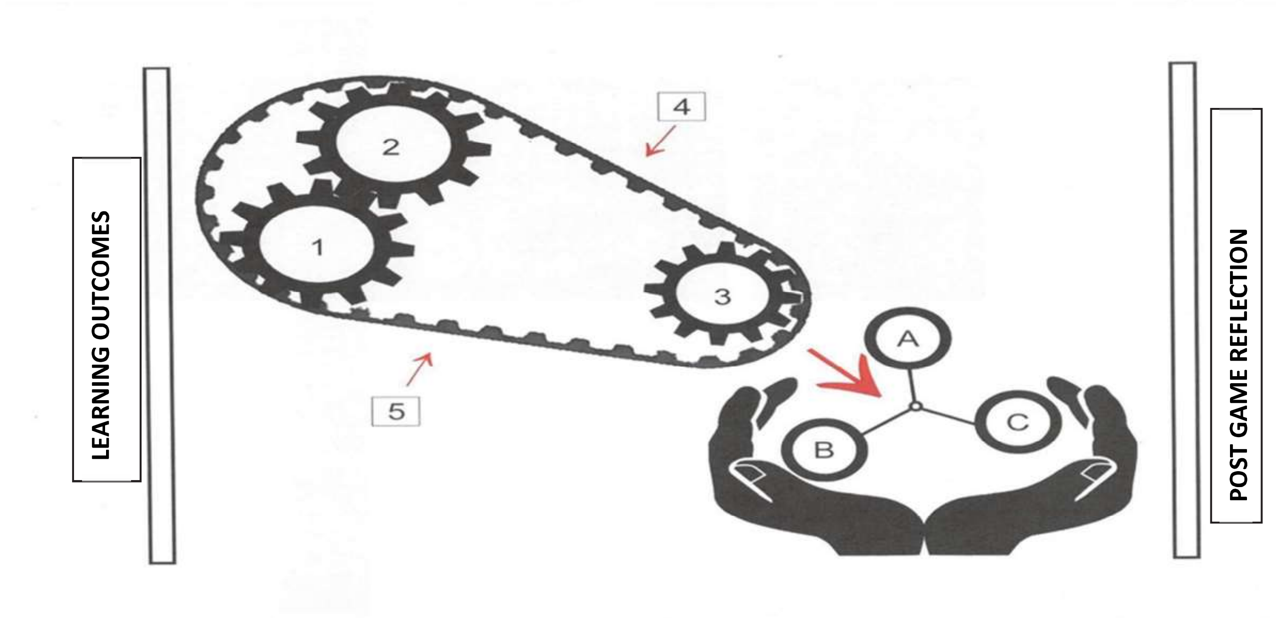
This was then further refined by the introduction of findings from the qualitative the study which used Interactive Qualitative Analysis (IQA) for data analysis and interpretation. The outcome of IQA process, designed by Northcutt and McCoy (2004), is the development of a System Influence Diagram (SID), which is a graphic illustration of the phenomena and the inter-relationships between the various themes (affinities).

Unpacking GAF

GAF in providing an explanation of how and why students learn from an economics gaming intervention, can be divided into three main areas: Learning Outcomes (LO), Games Space (GS)and Post Game Reflection (PGR). In the GAF model, the learning process from the gaming activity occurs between two pillars, namely Learning Outcomes and Post Game Reflection, both of which remain essential components as they provide the structure within which the deliberative activity and transformational play take place. The Learning Outcomes provide the starting point where the challenges are set and embedded with educational outcomes, and the Post Game Reflection represents the discussion linking the gaming challenges with the educational outcomes to ensure that deeper conceptual understanding of the concepts have been attained, i.e. ensuring the efficacy of the educational gaming intervention. (See Figure 1: Game Analysis Framework (GAF))

FIGURE 1
GAME ANALYSIS FRAMEWORK (GAF)

GAME SPACE – EDUCATIONAL GAMING ENVIRONMENT
PRIMARY DRIVER: USE MORE GAMES
PLUS
PRIMARY OUTCOME: DIDN'T FEEL LIKE A LESSON



SECONDARY DRIVERS
1. INVOLVEMENT/EXPERIENCE
2. FUN/ENJOYMENT/EXCITEMENT

RESULTING IN
3. DEEPER CONCEPTUAL

BEHAVIOURAL AND EMOTIONAL BUY-IN THROUGH ENGAGEMENT AND IMMERSION IN GAMES
RESULTING IN
4. AUTONOMY; COMPETENCE; RELATEDNESS; FEEDBACK

COGNITIVE ENGAGEMENT: ENACTMENT OF KNOWLEDGE (FEEDS BACK INTO THE SYSTEM)
5. EXPERIMENTATION, STRATEGY DEVELOPMENT, REASONING, CRITICAL THINKING

THIS LEARNING PROCESS CULMINATES IN THE ASSIMILATION OF KNOWLEDGE THROUGH

A. REALISATI ON
B. AWARENE SS

Between the two pillars is the learning environment, which is represented by the Game Space within which the gaming activity takes place. The primary driver revealed by the IQA process - 'Use More Games' and the primary outcome - 'Didn't Feel Like a Lesson' are catalysts of the Game Space and it is their interaction that facilitates the disruption of the traditional educational learning space by introducing active learning into the classroom.

Within this Game Space, it can now be depicted to 'how' and 'why' students learn from an educational gaming activity, derived from the findings of this research. This takes the form of two processes, the first of which is a cogs-and-belt system that unlocks the 'safe' of deeper conceptual understanding ('how') and the second illustrates 'why' students learn from the educational gaming intervention after reaching that 'aha' moment.

The centre-piece of GAF is the Game Space, which is made up of a cogs and belt system that takes place within an active educational learning environment as encapsulated by the two affinities: primary driver, 'Use more Games' and the primary outcome, 'Didn't Feel Like a Lesson'. Together they created an interactive and stimulating environment where everyone was involved and paid attention.

The seeds of this educational environmental transformation lie in active learning where student activity and engagement become the defining parameters (Prince 2004). In other words, student participation is key to the process of learning beyond listening and taking notes. Here, constructivism adds value as to what is meant by student activity, namely becoming co-constructors of knowledge and taking ownership of the learning process.

'Use more Games' emerged as the primary driver through the students' reports that, because of direct involvement and participation, the abstract theory had developed into a tangible reality that was meaningful and had substance. They could develop coherent arguments as they discerned and melded Economics concepts out of the gaming experience, developing a tapestry of meaning together with a holistic understanding of the topic. This was accomplished by placing the students at the centre of the learning experience, taking on the roles of economic agents in the Economics gaming intervention.

With respect to the primary outcome - 'Didn't feel like a Lesson', students reported no longer being bored, but rather paying attention and absorbing information which enabled them to connect the previously abstract theory which had been alien to them, finding freedom and enjoyment as they grappled with the challenges. They revelled in the opportunity to negotiate their own paths through the challenges of the Economics games. The classroom had changed into a dynamic environment that was vibrant and bustling, a total reversal of what they considered a formal lecture to be. Their label 'Didn't feel like a lesson' was the means of describing the fact that it was still a lesson as they left the classroom with a deeper conceptual understanding of the Economics topics.

'Use More Games' and 'Didn't Feel Like a Lesson' were the keys to allowing students to actively experiment and overcome the learning challenges posed by the game and create a meaningful student-centred learning environment where they were enabled to apply, practice and demonstrate knowledge. It is within this context, according to Najidi and El Sheikh (2012) and Boyle et al. (2014), that the playing of educational games results in: students retaining more information; improving their cognitive abilities; the deepening of their conceptual understanding; improvement of their transfer of knowledge to other topics; engagement in collaborative learning; development of strategies for logical and scientific reasoning; critical thinking; and the use of evidence and argument, whilst still remaining enjoyable and engaging.

PIVOTAL ROLES OF 'INVOLVEMENT/ EXPERIENCE' AND 'FUN/ ENJOYMENT/ EXPERIENCE'

The cogs-and-belt system in the GS is driven by two main cogs, the first of which - 'Involvement/ Experience' initiates the momentum of the belt-driven system by interlinking directly with the second cog – 'Fun/ Enjoyment/ Experience'. This is a reciprocal relationship where their combined interaction adds greater traction to the learning process. This traction, in turn, sets the belt in motion which drives the third cog, namely 'deeper conceptual understanding'. Once the belt is in motion, this becomes a continuous process driven by the cogs.

The belt itself comprises two components - behavioural and emotional engagement (4) and the enactment of knowledge (5). The former, behavioural and emotional buy-in, immerses students in the gaming process by encouraging autonomy, facilitating competence and relatedness that is complemented by immediate feedback. This then leads to the second stage – the enactment of knowledge that allows for cognitive engagement which includes experimentation, strategy development, goal formation, reasoning and critical thinking that then loop into the system.

COG 1 - 'INVOLVEMENT/ EXPERIENCE'

Without involvement, there can be no experience and without experience, there can be no buy-in. Involvement goes beyond mere participation and interaction: it acts as the gatekeeper to a personalised understanding of the concepts embedded in the gaming intervention. Ryan and Deci's (2000) Self-determination Theory aptly describes what is needed for student motivation and commitment to the learning process – the desire to remain involved and delve deeper into the concepts. Through the learning experience, the secondary driver, 'Involvement/Experience' evolves beyond its initial definition by students leading me to search for a term which better encompasses students' experience, namely, 'engagement'.

"Engagement is the reflection of the positive development of an individual. In the context of schooling, engagement describes the level of energy or effort students invest in learning activities which has positive consequences, notably on achievement and well-being" (Hospel and Galand, 2016, p.1.).

Student engagement, within the learning context, is seen as a composition of emotional, cognitive and behavioural facets which are influenced and moulded by the contextual factors of the learning environment. In other words, the manner in which students engage with activities such as participation and interaction (behavioural); positive and negative reactions (emotional); and learning strategies (cognitive) determine the depth of their engagement (Hospel and Galand, 2016). It is the learning environment, according to the Self-determination Theory (Ryan and Deci, 2000), which provides the setting for the achievement of student autonomy, competence and relatedness which catalyses deeper conceptual understanding through student engagement. Games provide a highly autonomous and highly structured environment for this engagement to occur. They enable students to evolve through taking control of their own learning experiences and being able to make their own real-time decisions, which in turn results in autonomous, highly motivated learners with both behavioural and emotional buy-in.

However, autonomy is not as effective if it is not complemented with structure and this is where an educational gaming environment provides both the essential support and guidance for achieving competence. This is supported by Hospel and Galand (2016), who state that "Given the pivotal role of engagement for achievement and academic success, the identification of the classroom factors related to engagement is a major issue" (Hospel and Galand, 2016, p.1.). The educational gaming environment, as mentioned previously, is not merely successful due to the level of autonomy it creates for students, but rather due to the structure which is provided through the rules and feedback to accomplish the embedded learning outcomes. The structure of the game enables students to focus their attention on particular outcomes as they move from one stage of the game to the next. This allows them to develop a sense of competence as they overcome challenges which increase in difficulty. The immediate feedback provided by the game plays an important role in this process. One may think structure and autonomy are non-compatible, but this is not the case, as structure enables one to focus on the task at hand and not be distracted by the peripherals.

The positive effect of structure and its link to engagement can best be explained using Cognitive Load Theory (CLT) (Kirschner, Sweller and Clark, 2006). Within the educational gaming environment, the structure provides specific guidance which lessens the CLT as it eases the pressure on the working memory by allowing students to focus their attention on the tasks at hand. This facilitates learning as it stimulates emotional and behavioural engagement, resulting in the formulation of cognitive strategies to overcome the challenges posed by the game. However, it is not only the game which provides the support and structure, but also the lecturer who has become a facilitator and guide, showing the students where and how the game elucidates the concepts and links the theory with practice. This feedback, together with the immediacy of the feedback by the game, allows for the students to personalise their experience and take control of their own learning, i.e. become self-determined learners.

By engaging optimally with the game, students are now on a level playing field with their peers where they not only begin to relate to one another, but are enabled to relate their experiences within the game to the outside world. This relatedness empowers students to be able to converse about economic concepts and apply them in their everyday lives, traversing the boundary between theory and practice. Such is the authenticity of the learning experience which is provided by the deliberative activity within the educational gaming environment. However, more research needs to be undertaken to further investigate the importance of relatedness to the development of self-determined learners who are motivated and wish to delve deeper into the academic theory.

COG 2 - 'FUN/ ENJOYMENT/ EXPERIENCE'- POSITIVE EMOTIONS

As mentioned earlier, emotional buy-in is an integral facet of 'how' and 'why' students learn from games and from this study, there seems to be a positive correlation with engagement to unlock deeper conceptual understanding. Emotions, according to Pekrun et al. (2011), have a "significant role to play in directing interactions, learning and performance within educational settings" (Pekrun et al, 2011, p.13). In fact, they argue that educational settings are permeated with emotion, and therefore need to be carefully considered when designing learning environments. By introducing an educational gaming intervention, emotions are harnessed, which not only direct attention and focus but also have an important role to play in the retention of knowledge.

In this study, the educational Economics games elicited positive emotions and, in fact, moved the students from a state of boredom and disengagement to that of enjoyment coupled with full immersion in the learning environment.

> *"(I) find it hard to listen all the time and not find something distracting and just pay attention, sometimes (it's) hard, so it's better if we're doing something fun and interesting that we can all pay attention to"*[1]

As a result of these positive emotions, students became motivated and energised to engage with the material. It is as if they were now open to and daring to learn more. This is consistent with Fredrickson's (1998) findings that positive emotions aid problem-solving, causing students to pay attention and reflect upon what they have learned, thereby increasing the efficacy of the learning process.

In fact, the effects of the positive emotional learning experiences are permanent. The IQA process elucidated these effects as not only lasting for the period of the game, but influencing students' ability to retain learning beyond the classroom. These positive emotions tend to imprint the memory of the game in such a way that they could recall the experience to help them solve problems within various settings from tests to everyday life.

> *"while you're studying, you remember this is what happened, exactly and you have to apply it that way, it makes it easier"*

Pekrun et al. (2011) provides an integrated framework that explains the development of emotions within an educational setting via the Control Value Theory, which comprises four inter-related dimensions: Environment, Appraisal, Emotions, as well as Learning and Achievement. With respect to emotions, they refer to the importance of achievement emotions which simply put, are directly related to the achievement of an activity or outcomes. The achievement emotions evidenced in this study, namely 'fun/enjoyment/excitement' came to the fore during the gaming intervention, replacing the boredom often experienced during a traditional lecture.

According to the theory, the process begins with the student making an appraisal of the educational environment. The achievement emotions which arise then affect the student's learning and achievement. This appraisal takes into consideration the achievability of the task (i.e. whether it can be initiated, performed and the learning outcomes attained); and then subjective value is assigned to that task –

intrinsic (appreciation of the task/activity) and extrinsic (the practicality of the task/activity and the ability of the outcomes to produce further outcomes). This perceived controllability and value, according to Pekrun et al. (2011), leads to positive enjoyment as opposed to the opposite extreme, boredom which arises through a lack of value and controllability being placed on a task/activity. According to Pekrun et al. (2011), if the student is anticipating success then joy is elicited. By introducing the gaming intervention, the new Economics environment elicited enthusiastic students who became visibly engaged, focused and enjoyed the tasks at hand. The controllability, value and positive appraisal from students resulted in more cognitive resources being made available for the task, resulting in deeper conceptual understanding. As this enjoyment increased, so did students' interest and motivation to learn. This led to the development of holistic, flexible and creative strategies for learning and problem-solving (re-inforcement of Pekrun et al.'s (2011) Control Value Theory). This enjoyment can be contrasted to the boredom encountered during a traditional lecture, as reported by the students during the semi-structured interviews, where disengagement led to a loss of interest and motivation. The importance of the educational learning environment in shaping these positive emotions cannot be minimised and, in fact, make or break the efficacy of learning (Pekrun et al., 2011).

COG 3 – DEEPER CONCEPTUAL UNDERSTANDING

Deeper Conceptual Understanding is set in motion by the first two cogs – namely 'Involvement/Experience' and 'Fun/Enjoyment/Excitement'. As can be seen from the diagram there is an arrow leading from the third cog to a pair of open hands that contains a molecule made up of A, B and C.

The reason for this is two-fold, firstly to show where the Deeper Conceptual Understanding lies namely, in the hands of the students. The hands were chosen to symbolise that the knowledge gained resided not only in brain but as a tool they can manipulate to make sense of the world. Secondly, the molecule of A, B and C is there to show the different facets of the concept of Deeper Conceptual Understanding, as well as, that these facets can occur in any order as they learner progress through the gaming environment.

DEFINING DEEPER CONCEPTUAL UNDERSTANDING

According to the molecule indicated in the diagram, Deeper Conceptual Understanding is attained through the facets of A - Conceptual Realisation, B-Conceptual Awareness, and C – Integration/Application that are woven together as students pass through the gaming intervention that results in a crystallisation of concepts that allows for their application beyond the classroom into real world.

'CONCEPTUAL REALISATION'

'Conceptual Realisation' with respect to the theoretical economic concepts, is more than merely being able to define the concepts, but rather being able to make sense of the economic theory. The first steps towards 'Conceptual Realisation' begin with the crystallisation of concepts in a way that moves them beyond economic jargon and theoretical constructs, transforming them into useful tools that help decipher the nuances of economic reality. The activity and action in the game enabled students to make the tacit connections between the theory to which they had been previously exposed and their lived experiences in the gaming intervention. In this way, a personalised comprehension of the concepts leads to an in-depth understanding of the subject. For example:

"I understand what I am talking about and not just writing for the sake of writing".

Through the Economics gaming intervention, students gleaned an understanding that had meaning and substance, resulting in 'Aha!' moments.

> *"…I could really match it that okay, that I can call this term in a real world 'demand' and I can call this one 'supply'; you're not just drawing a graph and claiming what is happening, 'no!' Now you understand and you can actually apply it!"*

This convergence between abstract concepts and the lived reality of the game led to the economic concepts no longer being foreign to them, but rather becoming a set of tools that can be applied to their everyday lives. The visual and tangible nature of the game opened up a world of possibilities where they could make sense of the economic concepts, increase their interest in the subject and awaken their curiosity to discover more. Ultimately, it is a realisation that cannot be emulated by lectures and textbooks alone.

Due to the pre-planned, deliberative activity within the gaming intervention, realisation is made possible as the students are provided with sufficient background to enable them to make the connections while playing the games. It is a space where they, through feedback between themselves, the game and others, are provided with opportunities to build meaningful connections about theoretical concepts (i.e. it is as though the electrical circuit is complete, the light goes on and it just makes sense).

'CONCEPTUAL AWARENESS'

During the playing of an educational game, is the emergence of 'Conceptual Awareness' – an awareness which seems to be attained through actively observing the theory in action in an up-close, hands-on fashion. This, in conjunction with 'Conceptual Realisation', brings the concepts to life, enabling them to be observed from different perspectives where the interaction between the inter-related aspects of the theory can be seen.

> *"I like something that is practical, so the time I see what happened and how did it happen, I get to know, okay – this has to be done and this is how I need to do it"*

In this way, students reported that they could see a clear demonstration of the theory being taught; could link economic concepts together; and follow the economic reasoning through playing the game. It is as if the puzzle parts began to fit together and they could find the golden thread that linked the economic theory with the action of the game. As the theory gained substance, the students could elaborate on the concepts in their own words as their self-efficacy had increased due to learning being placed in their own hands. In this manner, they became self-determined learners who were 'driven' back to their textbooks to bolster their knowledge… and, what they saw in the game was reflected in the textbook with greater detail and more in-depth examples.

> *"Ja, ja I would say it did help because I mean when you get to the textbook and you read, you try to think of what are they trying to say to me. What is it saying, but with having something that is an experience of what is being said in the book then that helps you understand better."*

The game bound theory with practical application in a way that they understood the roles played by the economic concepts, so that they could assemble a clear and holistic comprehension of the topics under discussion. They now had a live awareness of the economic concepts and therefore could begin to develop their economic reasoning.

'CONCEPTUAL INTEGRATION'

'Conceptual Integration' is the final thread in the process of attaining deeper conceptual understanding. This integration of knowledge is a reflexive act that enables students to analyse the real world – moving the knowledge they had gleaned in the classroom beyond the academic boundaries of learning to the new setting of everyday reality. The more they realised the practical application of the theory in the real world due to the authentic nature of the games, the more traction the economic concepts began to have with respect to relevance and meaning. Ultimately, integration of the economic concepts melded with their lives outside the classroom, leading to statements such as *"I'm living it now"*.

The tangible reality of the economic concepts brought about by the educational gaming intervention as a deliberative activity in the classroom provided substance and relevance to previously abstract economic theory. Through transformational play, there was a change in ownership of the knowledge from being outside of them (i.e. alien to their way of thinking), to that of taking ownership of the knowledge and transforming it into a personalised set of tools which they could use to analyse and interpret the real world. Their engagement with, and immersion in, the educational gaming intervention was evidenced as deeper conceptual understanding of the economic concepts due to this melding of conceptual realisation, awareness and integration. As the students had built the connections themselves, the concepts crystallised in their minds and could therefore be applied in new contexts and environments that they encountered outside the classroom.

What Enables Deeper Conceptual Understanding?

Part of the answer, I believe, is provided by Cognitive Load Theory (CLT) which was developed by Sweller (1988). CLT provides a framework which focuses on the management of working memory as learners interact with the instructional material in order to achieve effective learning (de Araujo Guerra Grangeia et al, 2016). One's working memory is finite, as it can only hold the maximum of seven informational elements at a time (Young et al., 2014) and, if the load on the learner's working memory is exceeded, the result is a decreased efficacy of learning, thereby jeopardising the student's performance and attainment of knowledge.

CLT, according to Sweller (1988), identifies three cognitive loads which affect the working memory: intrinsic, extraneous and germane. The intrinsic load is controlled by the learner's level of expertise, as well as, the difficulty of the task – it cannot be affected by instructional interventions. The extraneous load, on the other hand, involves the search for information related to the performance of the task – the cognitive cost of processing information. This encompasses the information provided for the accomplishment of that task and is affected by the way in which the instructions are structured and presented. The third cognitive load, the germane load, involves the learner's mental efforts to construct schemata i.e. creating a permanent store of knowledge which is then retained in long-term memory (having infinite capacity) enabling task automation which does not need access to working memory.

As a result, we need to have more of the working memory dedicated to the germane load in order to facilitate deeper conceptual understanding. The only way in which this can be achieved, is to reduce the extraneous load because the germane load takes up the remaining space left by the sum of the intrinsic and extraneous loads. As the intrinsic load is fixed and the extraneous load is variable, the latter can be reduced to allow for a greater portion of the working memory to accommodate the expansion of the germane load.

Therefore, the design of instructional material should, according to CLT, aim to reduce the extraneous load by managing the intrinsic load and optimising the germane load (de Araujo Guerra Grangeia et al, 2016). Games have the ability to create complex learning environments that are able to manage the cognitive load in a way that facilitates optimal usage of working memory, resulting in effective learning. The reduction of the extraneous cognitive load is paramount if the germane load is to be optimised and expanded.

An effective means of reducing the extraneous load is through the use of worked examples which are structured in a way that the students have to follow a step-by-step process to find the solution to complex problems (Renkl, 1997). By introducing games into the economics classroom, students actively participate in authentic, complex tasks which are scaffolded in difficulty as they progress from the one challenge to the next, culminating in a deep conceptual understanding of the problem.

The three micro-economics games included in the economics gaming intervention – Pit Market Trading game (Holt 1996), Price Ceiling game (Kruse et al., 2005) and Widget game (Neral, 1993) created simulated environments in which the students were economic agents working through a series of embedded tasks to reach the learning outcomes of the games. This structured learning environment allowed for the students to focus their attention on the specific tasks at hand, compartmentalising actions – allowing them to know exactly what they had to do at each step of the game, thereby reducing their extraneous load. For instance, in the Price Ceiling game (Kruse et al., 2005), the students were allocated roles as landlords or renters. Initially this was a relationship which was based solely on the interaction between the landlords and the renters who were in the market for accommodation. The learning outcome at this stage was to show that markets converged to equilibrium. Then the complexity was added, namely, the implementation of a price ceiling – now, the landlords were governed by a maximum price (price ceiling) which they could charge as rental and as a result the market conditions changed.

According to Sweller (1988; 2004) worked-out examples reduce the extraneous load by freeing up the working memory enabling the students to concentrate their attention on solving the tasks at hand. By scaffolding the tasks, less working memory is needed to be allocated to processing each task because the student only needs to solve one challenge at a time, rather than the task as a whole.

As a result, these worked-out examples, as provided by the gaming intervention, increase the germane cognitive load because "they enhance understanding of the solution procedure" (Paas and van Gog, 2006, p. 5). In fact, not only do the students know "the procedural steps for problem-solving tasks, but also understand when to deploy them and why they work" (Gott et al. 1993, p. 260).

As games harness the learners' audio and visual senses simultaneously, their capacity to process information is enhanced. "Physically integrating multiple sources of information facilitates learning by reducing working memory load" (Mousavi, Low and Sweller, 1995, p. 320), therefore, by reducing the learners' dependence on one sensory channel (which could easily get saturated because it is finite) and spreading the load across two or more channels, their working memory capacity is expanded. This is often referred to as 'off-loading'. So, when a learner receives verbal and visual instruction simultaneously, it will generally, cause them to learn more efficiently than if the same instructions were received in only one format (Mayer and Moreno, 2003). In fact, games tend to create environments which encourage the use of multiple sensory channels ranging from visual to auditory to tactile, resulting in a vivid learning experience.

> *"We tend to capture them much more easier than words I think it is because of the colours, the pictures, the fun everyone you see the faces who did what who was part of this group which makes you remember when you are studying that ... Ja, so I think when you capture something it is easier for your brain to store and keeping the information in when you are reading from a text book"*

SUMMARY

At the heart of GAF is the development of an active learning environment which underlies the core of 'how' and 'why' students learn from educational games (as shown by the affinities 'Use More Games' and 'Didn't Feel like a Lesson'). Not only is this an autonomous setting where they are the agents of their own learning, but it also provides the structure essential to attain the pre-determined learning outcomes. Being a deliberative activity with transformational play, games foster persistent, motivated and engaged students who are self-determined learners. However, this can only occur with the buy-in from students on a cognitive, emotional and behavioural level so that they can immerse themselves in the games.

This engagement (as indicated by the cog – Involvement/Experience) is interlinked with an element of enjoyment elicited by positive emotions (as indicated by the cog - Fun/Enjoyment/Excitement) that assist in enhancing their problem-solving skills, encouraging reflection and focussing their attention on learning. These are the keys to successfully attaining deeper conceptual understanding, which is a product of the melding of conceptual realisation, awareness and integration with which students can traverse the boundaries of the academic setting and apply what they have learned to new contexts and settings in their everyday lives.

CONCLUSION

In looking at the overarching framework – GAF, to provide a model of 'how' and 'why' students learn from games, 'Involvement/Experience' is shown to be one of the key drivers in initiating the learning experience. The student engagement in the playing of the games on a behavioural, cognitive and emotional level has been explained using Ryan and Deci's (2000) 'Self-Determination Theory'. However, further research is required to see if there are any other factors apart from autonomy, competence and relatedness that could add further insight.

Positive emotions also emerged as a key driver through the attribute 'Fun / Enjoyment / Excitement' which works in tandem with 'Involvement/Experience'. This study relied on Pekrun's (2006) 'Control Value Theory' to explain the complexity of the role played by emotions and how they affect the learning process. Much of the research undertaken into the roles of emotions has focussed on the ways in which negative emotions impact on students' learning (Abe, 2011). Study of the roles of positive emotions is an emerging field of research. It is possible that a better theory may emerge that may be more suitable for explaining the relationship between a student's positive attitude and deeper conceptual understanding.

Sweller's 'Cognitive Load Theory' (1988) was also utilised in this study to provide a possible theoretical explanation of the relationship between the use of educational games and deeper conceptual understanding. I feel that this only partly explains the relationship and further research is required to map out the mechanics of the interaction. However, for educational gaming interventions to be successfully implemented and embedded into the curriculum, easily accessible resources are needed by the lecturers, the compilation of which is a further area of research that needs attention.

ENDNOTE

1. Direct student quotes from research

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